Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

1.28
R31
cop. 2

ARS 52-22
May 1967

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
JUN 20 1967
CURRENT SERIAL RECORDS

HEAVIER LOADING OF WATERMELONS IN RAIL CARS AND PIGGYBACK TRAILERS

(A Study of Damage and Cost Reduction)

Agricultural Research Service
United States Department of Agriculture

ACKNOWLEDGMENTS

Growers, shippers, receivers, carriers, and cushioning material manufacturers and distributors helped make this study possible by furnishing materials, products, equipment, and facilities for the research. The following members of the Transportation and Facilities Research Division helped conduct the tests and analyze the data: Joseph P. Anthony, William F. Goddard, Jr., Boris P. Rosanoff, Russell H. Hinds, Jr., Thomas H. Camp, and Kenneth Myers. Mr. Camp has transferred to the Farmer Cooperative Service, U. S. Department of Agriculture; Mr. Rosanoff and Mr. Myers have retired from Federal Service. Dr. Victor C. Beal, Jr. of the Biometrical Services Staff of ARS made the statistical analysis of the data.

CONTENTS

HEAVIER LOADING OF WATERMELONS IN RAIL CARS AND PIGGYBACK TRAILERS

(A Study of Damage and Cost Reduction)

By William R. Black and Philip L. Breakiron
Transportation and Facilities Research Division
Agricultural Research Service

SUMMARY

Rail car shipments of Charleston Grey watermelons of good carrying quality and condition can be loaded 6 and 7 layers high instead of the customary 5 layers high without a significant increase in damaged and decayed melons.

Calculations using railroad out-of-pocket costs show that more than $170,000 could have been saved by transporting in 7-layer loads all the melons shipped from southeastern producing areas to northern markets in one year. Total savings of about $7,000 in the costs of material used to cushion the loads also would have been realized from heavier loading of the melons.

The percentage of melons cracked and bruised during transport was higher in rail cars loaded 6 and 7 layers higher than in those loaded only 5 layers, but differences were not statistically significant. Losses from decay followed a similar pattern. For piggyback shipments, the percentage of melons damaged was greater in the heavier loads, but total melons damaged were few in these shipments.

Studies to compare the effectiveness of straw cushioning with polystyrene foam in reducing melon damage in rail shipments showed no significant differences in the performance of the two materials, but foam gave better results than straw cushioning in piggyback shipments. In one rail car shipment with half the melons cushioned with straw and the other half with the polystyrene foam, temperatures of the melons loaded on the foam were lower during transit than those loaded on straw. The costs of the two types of cushioning materials were about the same.

To obtain the full benefits of heavier loading (1) only melons of good carrying quality and condition should be shipped in the heavier loads, (2) adequate amounts of cushioning material should be used on the floors and walls of the transport vehicles, (3) the shipments should be transported to destinations as quickly as possible, and (4) the melons should be unloaded promptly.

INTRODUCTION

Transport costs were about one-third of the average wholesale price of watermelons shipped from Florida to northern markets in 1963. These costs are a much greater part of market value for watermelons than for many other fresh farm products shipped by rail.

Per-melon transport costs for watermelons can be reduced by putting more melons in the transport vehicle. Carrying additional melons in the vehicle makes more efficient use of fuel, labor, and other resources used to transport the melons.

Loss and damage in refrigerator car shipments of watermelons have been high for many years. The railroads, therefore, feared that heavier loading of the melons in refrigerator cars would result in substantially higher loss and damage payments.

This research sought ways to increase the quantity of watermelons loaded in a rail car or a piggyback trailer without an increase in damage and decay great enough to offset transport-cost savings from the heavier loading. Studied were stacking the Charleston Grey variety of melons higher in transport vehicles, and using polystyrene foam as a cushioning material. Straw is the usual cushioning material.

SCOPE AND METHOD OF STUDY

Load Height

Rail car shipments.--Transport researchers studied straight rail car shipments of long-type watermelons in three shipping seasons to gather data to compare melon damage and decay in different load heights. All the melons were loaded crosswise of the car. The melons were stacked five layers high in 16 cars, six layers high in 7 cars and seven layers high in 15 cars. The customary load height is 5 layers.1/ The data were analyzed to determine the statistical significance of the differences in melon damage.

The Charleston Grey melons were shipped to northern markets from producing areas in Florida, South Carolina, North Carolina, and Virginia. All the melons were in good condition and had good carrying quality. Data on condition of the loads, physical damage, and decay were obtained by inspecting all the melons at shipping points and destinations.

1/ Definition of loading terms:

A layer is one melon high and extends the full width and length of the load.

A row is one melon wide and one melon high and extends the full length of the load.

Transport costs and estimated savings from heavier loading of rail shipments were calculated from the rail carload cost scales published by the Interstate Commerce Commission.

Piggyback shipments.--Four piggyback trailer shipments were studied to see how heavier loading affected melon damage. The melons were stacked 6 layers high in the front half and 7 layers high in the rear half of one trailer and 7 and 8 layers high in three trailers. The melons were stacked one layer higher in the rear half of the trailers to distribute the weight over the axles of the tractor-trailer combinations in a way that would meet the legal maximum weight limitations in origin and destination States and still allow as large a payload as possible.

No statistical analysis was made of the load height data for the piggyback shipments because of the limited number of tests.

Load Cushioning

Rail car shipments.--Melon damage in 20 cars cushioned with polystyrene foam was compared with that in 18 cars cushioned with straw. The data were analyzed statistically to determine the significance of differences in melon damage.

In the foam-cushioned shipments, six 10-inch-wide strips of polystyrene foam, ½-inch thick, were placed on the car floor racks under each row of melons (fig. 1). Each end wall of the cars was cushioned with 6 polystyrene foam sheets, 33 by 36 by ¼ inches. This cushioning material was held in place by 3/8-inch staples.

The straw cushioning was placed on the floor and between the melons and the end walls.

Melon temperatures in one rail car shipment were studied to see how the type of cushioning material affected melon temperatures during transit. The melons in this shipment were stacked 7 layers high. Half the load on one side of the car was cushioned with straw and the other half with polystyrene foam. Temperatures of the melons in both halves of the load during transit were obtained by thermocouples inserted in the melons. The temperatures from 8 locations in each half of the load were recorded at 3-hour intervals on a recording potentiometer. Also, air temperatures on each side of the load and outside the car were recorded on the same instrument.

A comparison was made of the costs of polystyrene foam and straw used to cushion the 5-, 6-, and 7-layer loads of melons shipped in rail cars.

Piggyback shipments.--Two piggyback trailer loads were studied to see what melon damage would be for each of the two types of cushioning and when no cushioning material was used. The melons in both loads were stacked 8 layers high in the front half of the trailer and 9 layers in the rear half. The cargo areas of the trailers were divided into three approximately equal areas. One area had no cushioning material, one was cushioned with straw, and the third with polystyrene foam. Differences in melon damage were not analyzed for statistical significance.

BN29477

Figure 1.--Partly loaded rail car with long-type Charleston Grey watermelons; polystyrene foam cushioning is on car floor racks.

RESULTS

Load Height

Rail car shipments.--Data on the amount of damage and decay by height of load are shown in table 1. The percentage of melons cracked was 0.5 in the 5-layer loads, 2.4 in the 6-layer loads, and 2.1 in the 7-layer loads. Bruising was more prevalent than cracking, with 3.2 percent of melons bruised in the 5-layer loads, 5.3 percent in the 6-layer loads, and 6.3 percent in the 7-layer loads.2/

The variation or differences in the percentage of melons cracked and bruised were caused chiefly by factors other than load height. Previous research has shown that other factors that influence the amount of cracking

2/ Differences in percentages were not statistically significant for either cracked or bruised melons. See Appendix table 7 for analysis of variance.

TABLE 1.--Melon damage and decay in rail car shipments of watermelons, by height of load 1/

Height of load	Shipments	Melons inspected	Cracked melons	Bruised melons	Total melons cracked and bruised	Decayed melons	Total melons cracked, bruised, and decayed
	Number	Number	Percent	Percent	Percent	Percent	Percent
5 layers	16	23 648	0.5	3.2	3.7	1.3	5.0
6 layers	7	11,852	2.4	5.3	7.7	8.1	15.8
7 layers	15	28,588	2.1	6.3	8.4	5.6	14.0

1/ Loads cushioned with straw or polystyrene foam. Differences not statistically significant. See Appendix table 7 for analysis of variance.

and bruising of the melons in rail shipments are the maturity and carrying quality of the melons at time of shipment, the loading patterns used, and the care used in handling and transporting the melons.3/

The percentage of melons decayed was 1.3 in the 5-layer load, 8.1 in the 6-layer load, and 5.6 in the 7-layer load. These differences were not statistically significant. Decay is influenced less by load height than by other factors, such as growing conditions and exposure of the melons to decay organisms.

The 6- and 7-layer loads had less longitudinal shifting in transit than the 5-layer loads. This suggests that the heavier loads were more stable in transit than the 5-layer loads.

Data in table 2 show how heavier loading of melons in rail cars can reduce the costs of transporting the melons. Increasing the load height from five to six layers would save 18 cents a hundredweight on the basis of 1962 railroad out-of-pocket costs reported by the Interstate Commerce Commission. Increasing the load height from five to seven layers would save 32 cents a hundredweight. If all melons shipped by rail from southeastern producing areas to northern markets in 1962 had been stacked seven layers high instead of five layers, the transport cost savings would have been more than $170,000. These savings would have resulted from using 503 fewer cars to ship the same number of melons.

Savings in the cost of cushioning material also can be achieved by increasing the number of layers in a load of melons. This is possible because only the floor and end walls of the car are cushioned, and the same amount of cushioning material is used to cushion the melons in 5-, 6-, and 7-layer loads.

Data on the cost of both straw and polystyrene foam by load height are given in table 3. If all the melons shipped by rail from the southeastern producing areas to northern markets in 1962 had been stacked 6 layers high, total savings in the cost of cushioning material would have been $4,175 for straw and $4,042 for polystyrene foam. If all loads had been 7 layers high, the total savings would have been $7,143 when straw was used and $6,916 when polystyrene foam was used.

Piggyback shipments.--Data on damaged and decayed melons in one 6- and 7-layer load and three 7- and 8-layer loads shipped by piggyback trailers are given in table 4. They show that the percentage of total melons shipped that were cracked and bruised was much greater in the 7- and 8-layer loads than in the 6- and 7-layer load, but the number of melons damaged in loads of both height ranges was small.

3/ Breakiron, P. L., Winston, J. R., Kaufman, J., and Chester, B. Earl. Crosswise Loading of Long Type Watermelons, U. S. Dept. Agr. Mktg. Res. Rpt. 133, 35 pp, 1956.

TABLE 2.--Out-of-pocket railroad costs of transporting watermelons in rail cars from southeastern producing areas to northern markets, 1962, and potential savings from heavier loading of rail cars 1/

Height of load	Weight of carload 2/	Cars required	Out-of-pocket costs			Potential savings from heavier loading		
			Per 100 lb.	Per car 3/	Total 3/	Per 100 lb.	Per car 3/	Total 3/
	Pounds	Number	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
5 layers	30,595	1,759	1.29	395	694,242	--	--	--
6 layers	36,722	1,465	1.11	408	597,139	0.18	66	96,836
7 layers	42,849	1,256	.97	416	522,044	.32	137	172,219

1/ Out-of-pocket costs were calculated from Rail Carload Cost Scales by Territories of the Year 1962, ICC Statement No. 2-64, Bureau of Accounts, Cost Finding Section, March 1964, on the basis of all the melons shipped from Southern to Official Territory (generally north of the Ohio and Potomac Rivers and east of the Mississippi River) in 1962, and the number of cars that would have been required to load the melons at the three load heights.

2/ Calculated on the basis of 296 melons per layer and 20.7 pounds per melon.

3/ Figures have been rounded.

TABLE 3.--Shipper costs of cushioning materials in rail cars of watermelons transported from southeastern producing areas to northern markets, 1962, and potential savings from heavier loading of rail cars 1/

Height of load	Weight of carload 2/	Cars required	Cost of cushioning material 3/			
			Per 100 lb.		Total	
			Straw	Polystyrene	Straw	Polystyrene
	Pounds	Number	Dollars	Dollars	Dollars	Dollars
5 layers	30,595	1,759	0.0464	0.0449	24,978	24,186
6 layers	36,722	1,465	.0387	.0374	20,803	20,144
7 layers	42,849	1,256	.0331	.0321	17,835	17,270

Height of load	Weight of carload 2/	Cars required	Potential savings from heavier loading			
			Per 100 lb.		Total	
			Straw	Polystyrene	Straw	Polystyrene
	Pounds	Number	Dollars	Dollars	Dollars	Dollars
6 layers	36,722	1,465	0.0077	0.0075	4,175	4,042
7 layers	42,849	1,256	.0133	.0128	7,143	6,916

1/ Calculated on the basis of all the melons shipped from Southern to Official Territory (generally north of the Ohio and Potomac Rivers and East of the Mississippi River) in 1962, and the number of cars that would have been required to load the melons at the three load heights.

2/ Calculated on the basis of 296 melons per layer and 20.7 pounds per melon.

3/ Based on the cost per car of $14.20 for straw and $13.75 for polystyrene foam. Cushioning is required only on the floor and at ends of the load, regardless of load height, so the per car cost is the same for all three load heights.

TABLE 4.--Melon damage and decay in piggyback shipments of long-type watermelons by height of load 1/

Height of load	Shipments studied	Melons shipped and inspected	Cracked and bruised		Decayed		Total, cracked, bruised and decayed	
			Number of melons	Percent of total melons shipped and inspected	Number of melons	Percent of total melons shipped and inspected	Number of melons	Percent of total melons shipped and inspected
	Number	Number	Number	Percent	Number	Percent	Number	Percent
6 and 7 layers	1	1,620	1	0.06	14	0.86	15	0.92
7 and 8 layers	3	6,101	43	.70	52	.85	95	1.56

1/ Loads cushioned with straw.

The percentage of total melons decayed was about the same for loads of both height ranges.

The piggyback loads were not subjected to the same switching impacts as the rail car shipments and almost no load shifting occurred in the trailers. Load disarrangement during transit was negligible and was confined to slight settling of melons.

Load Cushioning

Rail car shipments.--Data on the damaged and decayed melons for the 38 cars of all three load heights are summarized by type of cushioning in table 5. The percentage of damaged and decayed melons was about the same for loads cushioned with each kind of cushioning material.4/

Melon and air temperatures recorded during transit in a rail car shipment in which half the melons were cushioned with straw and the other half with polystyrene foam are shown in figure 2. The melons cushioned with

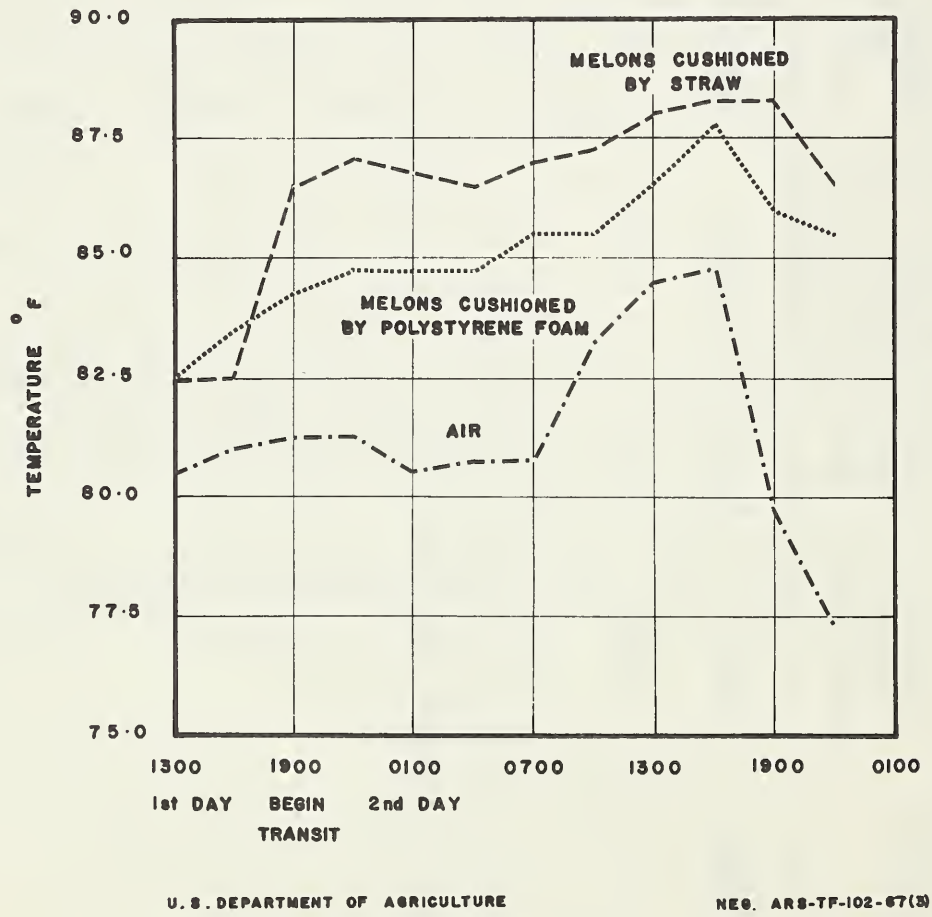

Figure 2.--Product and air temperatures during transport of watermelons cushioned by straw and polystyrene foam and stacked seven layers high in a refrigerated car.

4/ Differences not statistically significant. See Appendix table 7 for analysis of variance.

TABLE 5.--Melon damage and decay in rail car shipments of watermelons, by type of cushioning 1/

Type of cushioning	Shipments	Melons inspected	Cracked melons	Bruised melons	Total melons cracked, bruised, and decayed	Decayed melons	Total melons cracked, bruised, and decayed
	Number	Number	Percent	Percent	Percent	Percent	Percent
Straw	18	30,073	1.9	5.0	6.9	5.2	12.1
Polystyrene	20	34,015	1.5	4.9	6.4	4.8	11.1

1/ Differences not statistically significant. See Appendix table 7 for analysis of variance.

TABLE 6.--Melon damage in 8- and 9-layer piggyback loads of watermelons, by location in load and type of cushioning 1/

Type of cushioning	Wall rows 2/		Other than wall rows 2/		Total	
	Total damaged melons	Percent of total damaged melons	Total damaged melons	Percent of total damaged melons	Total damaged melons	Percent of total damaged melons
	Number	Percent	Number	Percent	Number	Percent
Straw	16	22.5	33	37.1	49	30.6
Polystyrene foam ..	12	16.9	19	21.3	31	19.4
No cushioning	43	60.6	37	41.6	80	50.0
Total	71	100.0	89	100.0	160	100.0

1/ Two trailers, with 8- and 9-layer loads in each trailer, evenly divided by type of cushioning.
2/ Number of melons shipped and inspected: 487 in wall rows and 4,153 in remainder of loads.

polystyrene foam had slightly lower temperatures during transit than the melons cushioned with straw. Also, the temperatures of melons cushioned with polystyrene changed more quickly in response to changes in the temperatures of the air circulated through the car during transit.

The use of straw to cushion the bottom- or floor-layer melons blocked the openings between the deckboards of the floor racks. This did not allow the incoming air to circulate upward through the load to remove heat from the melons during transit.

The polystyrene was cleaner to handle than straw and loading crews quickly learned to apply it to the cars. Also, the foam has no chaff nor dust to irritate the eyes and noses of loaders.

Piggyback shipments.--Less melon damage occurred in the areas of piggyback trailers cushioned with polystyrene than in the areas cushioned with straw. The percentage of total melons damaged in two piggyback shipments is given in table 6 by type of cushioning and location of the melons in the trailers. Of the total damaged melons in the loads, only 19.4 percent were cushioned with polystyrene foam; 30.6 percent were cushioned with straw and 50 percent had no cushioning.

Although the wall rows of melons were only about 10 percent of the loads, they accounted for 44.4 percent of all the melons damaged in the trailers. The wall rows of melons that had no cushioning accounted for more than 60 percent of the melons damaged in that load location, compared with 16.9 percent and 22.5 percent for the wall rows of melons cushioned with polystyrene foam and straw. These results indicate the need for cushioning the melons located next to the trailer walls, especially when the walls have ribs or strips on their surfaces.

CONCLUSIONS AND RECOMMENDATIONS

The costs of transporting long-type watermelons in rail cars can be reduced by heavier loading of melons. Loading melons of good carrying quality and condition 6 or 7 layers high, instead of the customary 5 layers high should not increase melon damage sufficiently to offset these savings. Differences between the percentages of damaged and decayed melons in 5-, 6- and 7-layer loads were not statistically significant.

The cost of cushioning material also is reduced by heavier loading of both rail car and piggyback shipments. The same amount of cushioning material is used for all load heights, so the per-melon cost of the material is lower for heavier loads.

Shippers, receivers, and carriers will obtain maximum benefits from heavier loading if they follow these recommendations based on this and other research on transporting watermelons:

1. The melons shipped in heavier loads should have good carrying quality and be in good condition.

2. All shipments should have adequate cushioning material on floors of refrigerator cars and trailers, on end walls of refrigerator cars and along the side walls of trailers.

3. All melons should be transported to destination as quickly and carefully as possible.

4. Both refrigerator carloads and piggyback trailer loads should be unloaded as soon as possible after arrival at destination.

APPENDIX

TABLE 7.--Least squares analysis of variance of damage to watermelons in rail car shipments, by source of variation

Source of variation	DF 1/	SS 2/	MS 3/	F-value 4/
CRACKING				
Years	1	1.1	1.1	1
Height	2	3.7	1.9	1
Cushioning	1	.7	.7	1
Height by cushioning	1	1.3	1.3	1
Years by height	2	3.1	1.5	1
Years by cushioning	1	1.9	1.9	1
Years by height by cushioning	1	.3	.3	1
Regression of damage on melon count by height	2	11.1	5.5	1.41
Regression of damage on gross melon weight by height	2	.2	.1	1
Regression of damage on average melon weight	1	6.6	6.6	1.68
Error	23	90.4	3.9	--
Total	38	189.0	--	--
BRUISING				
Years	1	8.50	8.50	1
Height	2	11.18	5.59	1
Cushioning	1	0.01	0.01	1
Height by cushioning	1	10.32	10.32	1
Years by height	2	64.60	32.30	1.09
Years by cushioning	1	4.53	4.53	1
Years by height by cushioning	1	1.06	1.06	1
Regression of damage on melon count by height	2	33.40	16.70	1
Regression of damage on gross melon weight by height	2	1.47	0.47	1

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Federal Center Building
Hyattsville, Maryland 20782

Postage and Fees Paid
U. S. DEPARTMENT OF AGRICULTURE

Official Business

Regression of damage on average melon weight	1	74.41	74.41	2.52
Error	23	679.59	29.55	--
Total	38	1,472.46	--	--
DECAY				
Year	1	8.8	8.8	1
Height	2	45.3	22.6	1.30
Cushioning	1	0.8	0.8	1
Height of cushioning	1	5.3	5.3	1
Years by height	2	16.1	8.0	1
Years by cushioning	1	20.5	20.5	1.18
Years by height by cushioning	1	18.9	18.9	1.09
Regression of damage on melon count by height	2	84.1	42.0	1
Regression of damage on gross melon weight by height	2	13.5	6.7	1
Regression of damage on average melon weight	1	1.5	1.5	1
Error	23	399.4	17.4	--
Total	38	1,211.2	--	--

1/ Degrees of freedom.
2/ Sum of squares.
3/ Mean square.
4/ Ratio of the respective mean square to the error mean square.